

A taxonomic revision of the genus *Adela* Latreille (Lepidoptera, Adelidae) from Japan

Toshiya HIROWATARI

Entomological Laboratory, College of Agriculture, Osaka Prefecture University,
Sakai, Osaka, 593 Japan

Abstract Japanese species of the genus *Adela* Latreille, [1796], are revised. Four species are recognized from Japan : *Adela reaumurella* (Linnaeus, 1758), *A. luteocilis* sp. nov., *A. luminaris* sp. nov. and *A. praepilosa* sp. nov. Although *A. nobilis* Christoph, 1882 has been believed to be distributed in Japan, it is found that most Japanese representatives formerly known as *A. nobilis* belong to a distinct species, which is described here as *A. praepilosa* sp. nov. Differences of sexual dimorphism, such as eye size and antennal length, seen among the males of closely related species, are inferred to be independently acquired in each species probably relating to their precopulatory behavior.

Key words Lepidoptera, Adelidae, *Adela*, new species, Japan, sexual dimorphism.

Introduction

Up to present, Japanese species of the genus *Adela* Latreille, [1796], have been assigned to two species, *Adela reaumurella* (Linnaeus, 1758) and *A. nobilis* Christoph, 1882 (Moriuti, 1982). The latter species was originally described from Vladivostok, the Russian Far East and subsequently recorded from Japan. However, I examined the type series of *A. nobilis* Christoph deposited in the Natural History Museum, London and found that the Japanese representative which has long been regarded as *A. nobilis* is a distinct species and *A. nobilis* itself is not distributed in Japan. In the present paper, Japanese species of the genus *Adela* are revised and the morphological differences among species such as male eye size and antennal length are described. The character evolution is briefly discussed in relation to their precopulatory behavior.

Materials and methods

For comparing eye size, horizontal eye diameter (hd) and minimum distance between eyes (md) were measured (Fig. 6B) for calculating “eye size index” (hd/md). Interocular index sensu Davis (1975) is not adopted here because measurement of interocular distance on the frons is sometimes impossible in *Adela* species unless the hairy labial palpus is removed. Male antennal length was measured for the specimens whose antenna is completely retained and nearly straight. “Antennal length index” (al/fl), *i. e.*, antennal length (al)/forewing length (fl) is calculated. Terminology used here follows Nielsen (1980, 1985).

Unless otherwise indicated, specimens examined here are deposited in the Entomological Laboratory, Osaka Prefecture University.

Abbreviations for institutions and collections :

BMNH : The Natural History Museum, London.

OMNH : Osaka Museum of Natural History, Osaka.

SEHU : Laboratory of Systematic Entomology, Hokkaido University, Sapporo.

UPO: Entomological Laboratory, Osaka Prefecture University, Sakai.

UT: Laboratory of Ecological Zoology, University of Turku, Turku.

ZLMU: Zoological Laboratory, Meijo University, Nagoya.

Adela Latreille, [1796]

Adela Latreille, [1796], *Précis Caractères génériques Insectes*: 147. Type species: *Phalaena reaumurella* Linnaeus, 1758, *Syst. nat.* (Edn 10) 1: 540, by subsequent monotypy.

Capillaria Haworth, 1828, *Lepid. Br.*: 519. Type species: *Phalaena viridella* Scopoli, 1763, *Ent. Carniolica*: 250, by subsequent designation by Meyrick, 1912, in Wytsman, *Genera Insect.* 133: 8.

Dicte Chambers, 1873, *Can. Ent.* 5: 73. Type species: *Dicte coruscifasciella* Chambers, 1873, *ibid.* 5: 74, by monotypy.

Male. Antenna with 1–3 long anteriorly projecting hook-pegs on 8–10 of the flagellum. Labial palpus 3 segmented with dense raised hairs; 1st short, 2nd long and slender, 3rd very short (Fig. 6A); short, not beyond vertex in *A. reaumurella*, long, beyond vertex in the other Japanese species. Legs, fore tibia with epiphysis. Forewing with R_3 and R_4 stalked, approximate or free. Hindwing M_1 and M_2 stalked.

Female. Forewing with R_3 and R_4 free. Antenna entirely smooth in *A. reaumurella*, but with basal rough scales in the other Japanese species.

Male genitalia. Tegumen dome-shaped, moderate in length. Uncus short; posterior margin more or less produced posteriorly at lateral corners. Valva subquadrate or triangular in lateral view. Anterior process of transtilla spatulate in *A. reaumurella*, but thorn-like in the other Japanese species. Aedeagus long and slender; anterior portion of suprazonal sheath usually curved dorsally; subzonal sheath with hand-like lamella apically. Juxta arrow-shaped; head large with prominent barbs.

Female genitalia. Apophyses posteriores and anteriores subequal in length. Vestibular lamella absent in *A. reaumurella*, but present in the other Japanese species. Corpus bursae small, ellipsoidal; signa absent in all Japanese species.

Remarks. As pointed out by Nielsen (1981), the male hook-pegs on the flagellum are considered to be one of the synapomorphies of the genus. The number of the hook-pegs varies individually and their function is still unknown.

In the Japanese *Adela* species except *A. reaumurella*, a distinct lamella is recognized in the inner wall of the vestibulum in the female genitalia. I call it “vestibular lamella” here. This may be characteristic of these species, though Razowski & Wojtusiak (1978), Nielsen (1980) and Küppers (1980) did not refer to it.

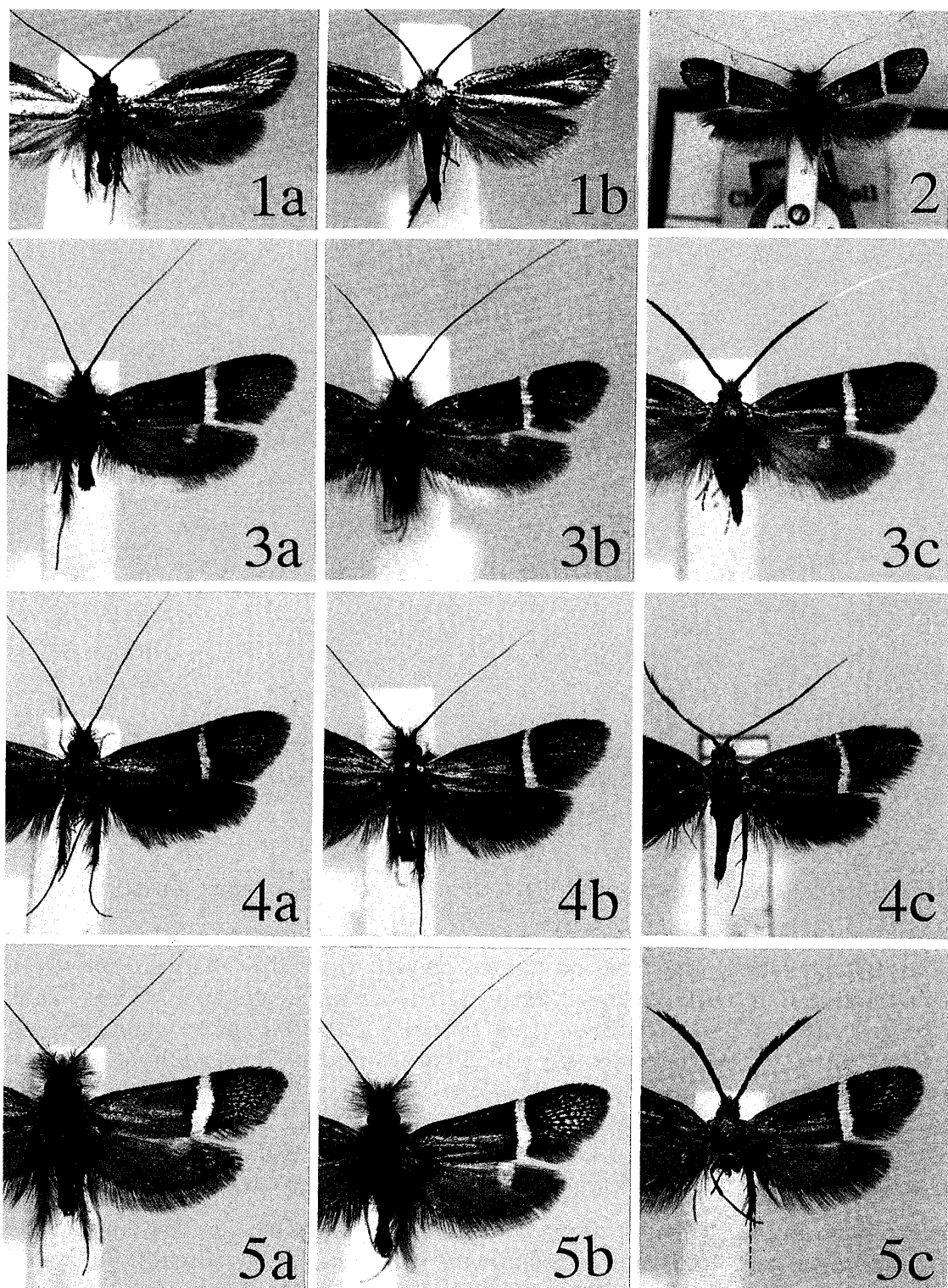
Redescription of *Adela nobilis* Christoph

As a result of the present study, it is found that *A. nobilis* Christoph is not distributed in Japan. In order to avoid confusion, redescription of the species is given and the lectotype and paralectotypes are designated.

Adela nobilis Christoph (Figs 2, 8)

Adela nobilis Christoph, 1882, *Bull. Soc. imp. Nat. Moscou* 57 (1): 7.

Male. Forewing 8.0–9.0 mm. Head with raised yellow hairs, sparsely set with black; face



Figs 1-5. *Adela* spp. 1. *A. reaumurella* (Linnaeus, 1758), a. ♂, b. ♀. 2. *A. nobilis* Christoph, 1882, paralectotype ♂ (BMNH). 3. *A. luteocilis* sp. nov., a. holotype ♂, b. paratype ♂, c. paratype ♀. 4. *A. luminaris* sp. nov., a. holotype ♂, b. paratype ♂, c. paratype ♀. 5. *A. praepilosa* sp. nov., a. holotype ♂, b. paratype ♂, c. paratype ♀.

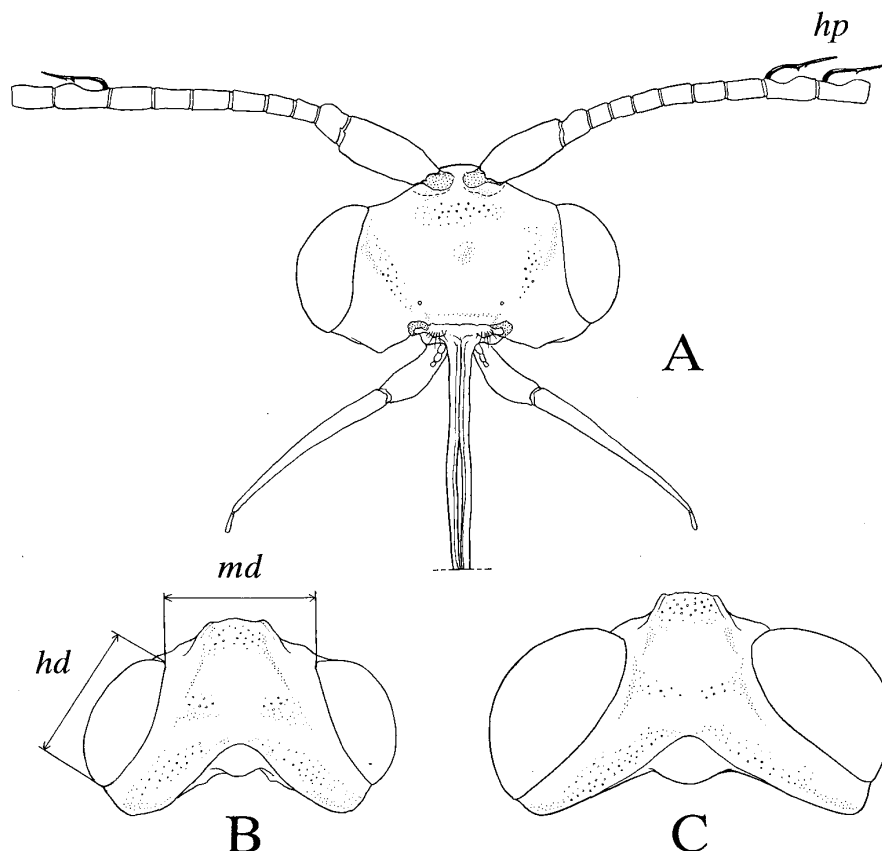


Fig. 6. Heads of *Adela* spp. A, B. *A. luteocilis* sp. nov., ♂. C. *A. praepilosa* sp. nov., ♂. A. frontal aspect. B, C. dorsal aspect. hp: hook-peg, hd: horizontal eye diameter, md: minimum distance between eyes.

with black hairs laterally, upper part (between antennae) yellow hairs mixed with black.

Eyes relatively large, horizontal eye diameter (hd)/minimum distance between eyes (md): 1.6–1.8. Labial palpus long, beyond vertex, densely covered with raised brown hairs. Antenna moderate in length, antennal length (al)/forewing length (fl): 2.6–2.8; basal 1/5 dark bronzy, distal 4/5 silvery white. Legs bronzy with purple luster; hind tibia bronzy with long yellow curled hairs dorsally; hind tarsus silvery white, without apical rings. Forewing with R_3 and R_4 free; basal half golden bronzy; a transverse white fascia relatively broad, margined with brownish scales of metallic purple luster; apical 1/3 dark brown with purple luster, radiately lined with golden yellowish scales. Hindwing dark brown with a small yellowish patch at costa medially; cilia ochreous to dark brown.

Female. Forewing 7.5–8.0 mm. Head with raised yellow hairs, face smooth and golden, lateral and upper parts (between antennae) with yellow hairs. Eyes small, horizontal eye diameter (hd)/minimum distance between eyes (md): 0.5–0.6. Antenna short, antennal length (al)/forewing length (fl): 1.3–1.4; basal half covered with relatively smooth black scales. Hindwing as in male.

Male genitalia. Uncus short; posterior margin weakly produced posteriorly at lateral corners. Valva basal half subquadrate, distal half dilated posteriorly in lateral view: distal half blade-like; basal part of ventral margin relatively long, about 1/4 of valva; ventro-posterior corner acutely angled. Anterior process of transtilla thorn-like. Aedeagus long

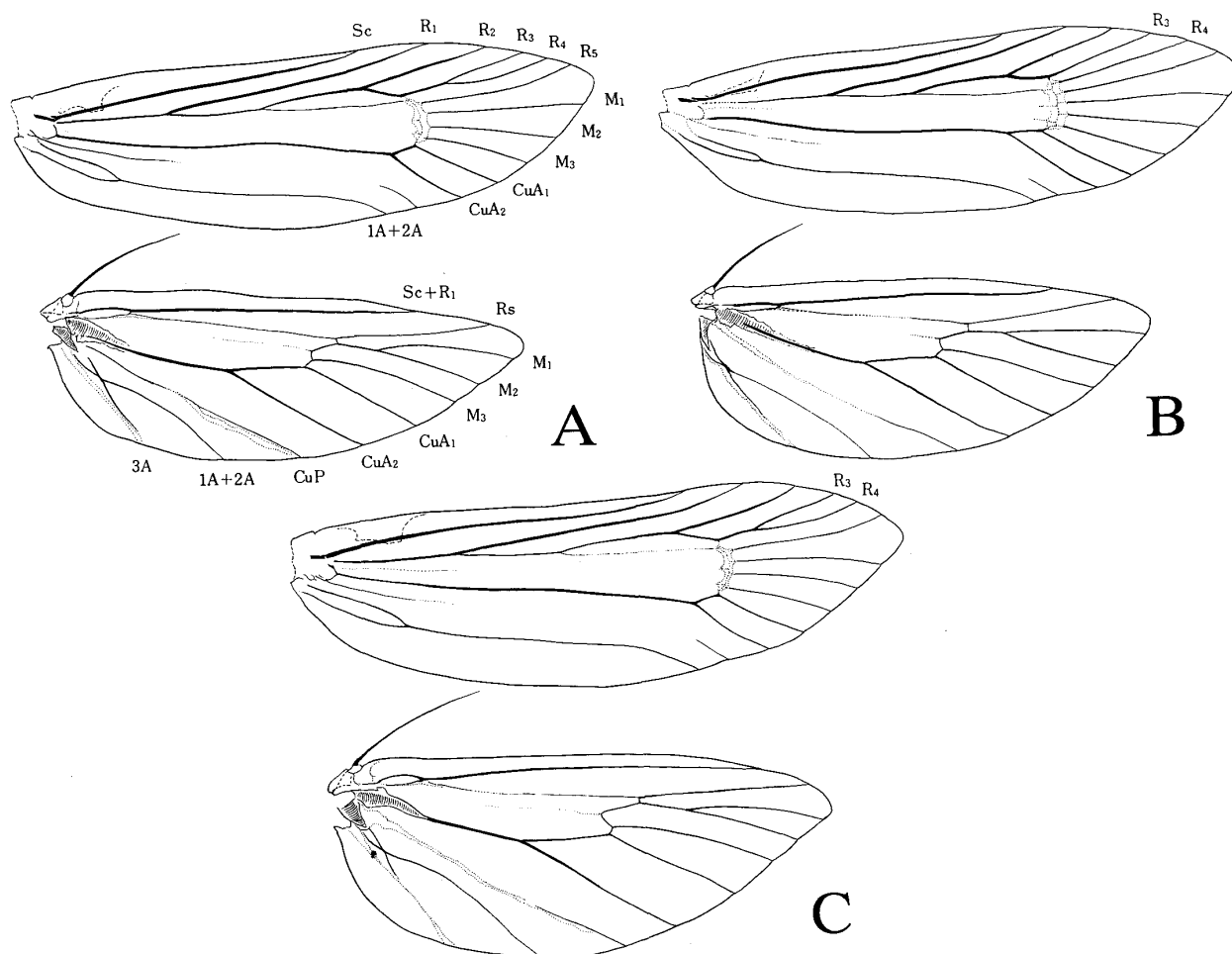


Fig. 7. Wing venation of *Adela* spp. A. *A. luteocilis* sp. nov., ♂. B. *A. luminaris* sp. nov., ♂. C. *A. praepilosa* sp. nov., ♂.

and slender; anterior portion of subzonal sheath weakly curved dorsally. Juxta arrow-shaped; head narrow, ellipsoidal.

Female genitalia. Not examined.

This species is distinguished from the Japanese representatives by the shape of valva in the male genitalia. It is difficult to identify this species externally, but the yellowish long hairs of hind tibia may be characteristic. All the specimens listed below are deposited in BMNH and the lectotype and paralectotypes had been selected by Dr M. Kozlov in 1994.

Lectotype ♂: paper circle with violet border, diam 8 mm, print "Lecto-/type"; 10×10 mm, black border, black ink "♂ ♀/Wladiwost[ok]/21 5 [18]77"; 6×13 mm, print "Christoph Coll."; 8×10 mm, print "Walsingham/Collection/1910-427"; 13×18 mm, print+black ink "Lectotype ♂/Adela/nobilis/Christoph,/1882/teste M. Kozlov, 1994".

Paralectotypes. 1 ♂; paper circle with blue border, diam 8 mm, print "Para-/lecto-/type"; 10×10 mm, black ink "♂ ♀/Wladiwost[ok]/8 6 [18]77"; 6×13 mm, print "Christoph Coll."; 8×10 mm, print "Walsingham/Collection/1910-427"; 13×18 mm, print+black ink "Paralectotype ♂/Adela/nobilis/Christoph,/1882/teste M. Kozlov, 1994". 1 ♂: paper circle with blue border, diam 8 mm, print "Para-/lecto-/type"; paper circle with red

border, diam 8 mm, print "Type"; purplish metallic circle diam 5 mm; bronze metallic circle diam 5 mm; 7×7 mm, black border, black ink "♂ Wladi/wost[ok]" reverse side "8 6 [18]77"; 6×13 mm, print "Christoph Coll."; 8×10 mm, print "Walsingham/Collection/1910-427"; 7×11 mm, yellowish paper, black ink "Type" 14×24 mm wide black border, print "TYPE"; 13×18 mm, print+black ink "Paralectotype ♂/Adela/nobilis/Christoph,/1882/teste M. Kozlov, 1994". 1 ♀: paper circle with blue border, diam 8 mm, print "Para-/lecto-/type"; paper circle with red border, diam 8 mm, print "Type"; purplish metallic circle diam 5 mm; bronze metallic circle diam 5 mm; 7×7 mm, black border, black ink "♀ Wladi/wost[ok]" reverse side "21 5 [18]77"; 6×13 mm, print "Christoph Coll."; 8×10 mm, print "Walsingham/Collection/1910-427"; 7×11 mm, yellowish paper, black ink "Type" 14×24 mm wide black border, print "TYPE"; 13×18 mm, print+black ink "Paralectotype ♀/Adela/nobilis/Christoph,/1882/teste M. Kozlov, 1994".

Key to Japanese species of *Adela*

1. Forewing with a white transverse fascia..... 2
 - Forewing uniformly metallic green *reaumurella* (Linnaeus)
2. Hindwing dark brown with a yellowish patch at discal cell end to costa; forewing transverse white fascia relatively broad; upper part of male face (between antennae) black, or black mixed with yellow hairs; male antenna short or long; male eyes small or large 3
 - Hindwing uniformly dark brown; forewing transverse white fascia narrow; upper part of male face (between antennae) with yellow hairs; male antenna long, about 3.6× as long as forewing; male eyes small (hd/md: ca 0.83) *luminaris* sp. nov.
3. Hindwing with dorsum of cilia yellowish; male eyes small (hd/md: ca 0.86); male antenna long, about 3.3× as long as forewing; female antenna with basal 1/2 covered with black scales *luteocilis* sp. nov.
 - Hindwing with cilia uniformly ochreous; male eyes large (hd/md: ca 1.9); male antenna relatively short, about 2.3× as long as forewing; female antenna with basal 1/3 covered with black scales *praepilosa* sp. nov.

Adela reaumurella (Linnaeus) (Figs 1, 9, 13A)

Adela reaumurella (Linnaeus, 1758), *Syst. nat.* (Edn 10) 1: 540; Moriuti, 1982: 1: 53, 2: pl. 1, fig. 23, [examined], pl. 235, fig. 7, pl. 247, fig. 2.

Adela viridella Scopoli: Matsumura, 1931: 1110; Matsumura, 1932: 127, pl. 4, fig. 23; Issiki, 1957: 12, pl. 1, fig. 22; Okano: 1959, 277, pl. 183, fig. 7.

Male. Forewing 8.07 ± 0.35 mm (mean \pm SD, $n=7$). Head with raised black hairs; face smooth and silvery, laterally with black hairs, upper part (between antennae) with yellow hairs. Eyes small, horizontal eye diameter (hd)/minimum distance between eyes (md): 0.53 ± 0.03 (mean \pm SD, $n=7$). Labial palpus short, not beyond vertex, sparsely covered with raised black hairs. Antenna long, antennal length (al)/forewing length (fl): 2.77 ± 0.15 (mean \pm SD, $n=7$); basal 1/5 dark bronzy, distal 4/5 silvery white. Legs bronzy; hind tibia bronzy, sparsely with long raised-hairs dorsally; hind tarsus bronzy, with apical silvery white rings. Forewing with R_3 and R_4 free; bronzy green, purple luster along costa; Hindwing dark brown with purple luster; cilia ochreous to brown.

Female. Forewing 7.20 ± 0.25 mm (mean \pm SD, $n=6$). Head with raised yellow hairs, sparsely mixed with black; face smooth and silvery, upper part (between antennae) with

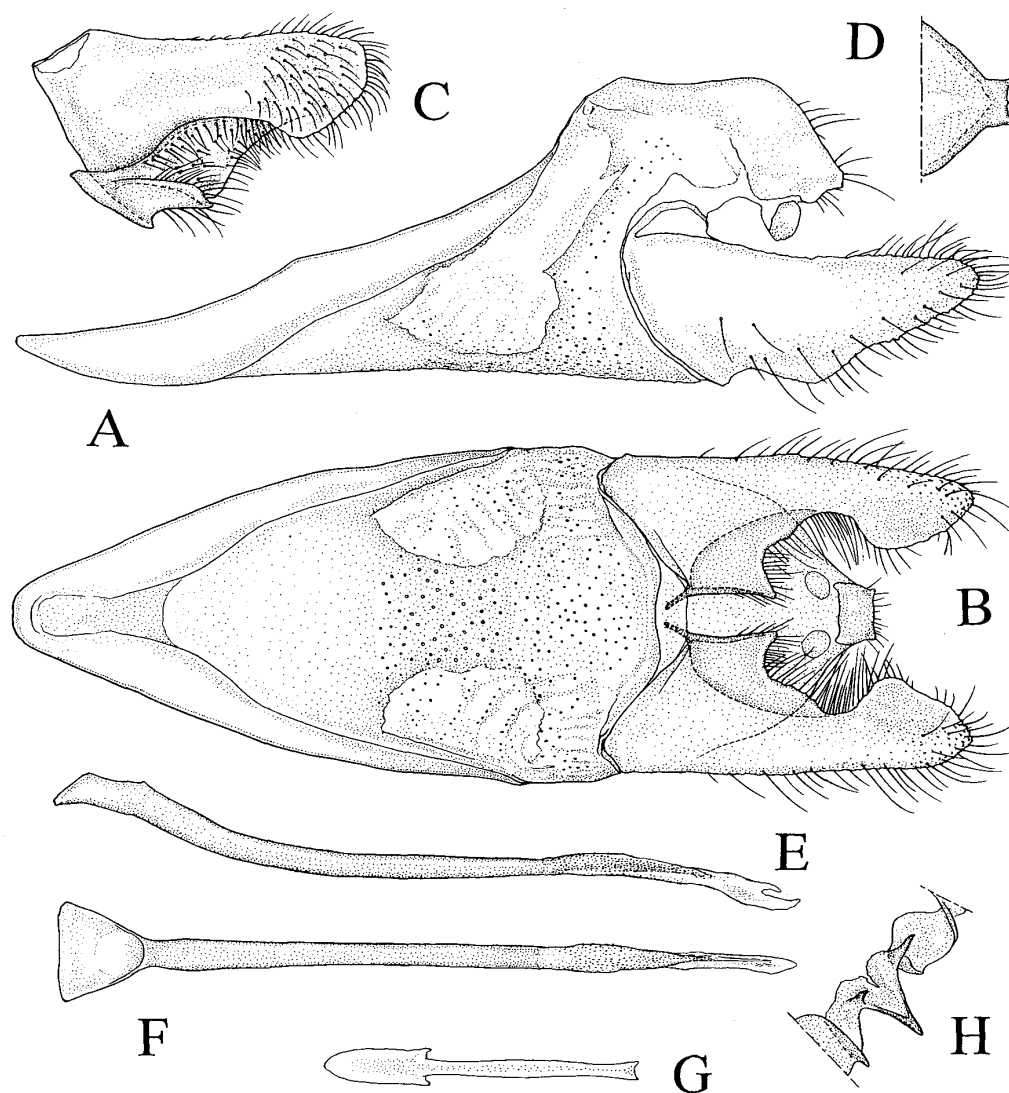


Fig. 8. Male genitalia of *A. nobilis* Christoph, 1882, paralectotype (BMNH). A. Whole genitalia except aedeagus in lateral view. B. *Ditto*, ventral view. C. Right valva in internal view. D. Dorsum in dorsal view. E. Aedeagus in lateral view. F. *Ditto*, dorsal view. G. Juxta in ventral view. H. Transtilla in dorsolateral (slightly caudal) view.

yellow hairs. Eyes very small, horizontal eye diameter (hd)/minimum distance between eyes (md): 0.45 ± 0.01 (mean \pm SD, $n=6$). Antenna short, antennal length (al)/forewing length (fl): 1.34 ± 0.06 (mean \pm SD, $n=6$); entirely smooth, apically white, basal half bronzy gradually thickened basally.

Male genitalia. Uncus relatively long, almost parallel-sided; posterior margin produced posteriorly at lateral corners. Valva subquadrate in lateral view; inner wall with a triangular apical hook; basal part of ventral margin long, about 1/3 of valva; ventro-posterior corner acutely pointed. Anterior process of transtilla spatulate, directed anterodorsally. Aedeagus long and slender; subzonal sheath curved dorsally at anterior 1/5. Juxta arrow-shaped; head ellipsoidal with prominent barbs.

Female genitalia. Apophyses posteriores and anteriores subequal in length. Vestibulum relatively small, vestibular lamella absent.

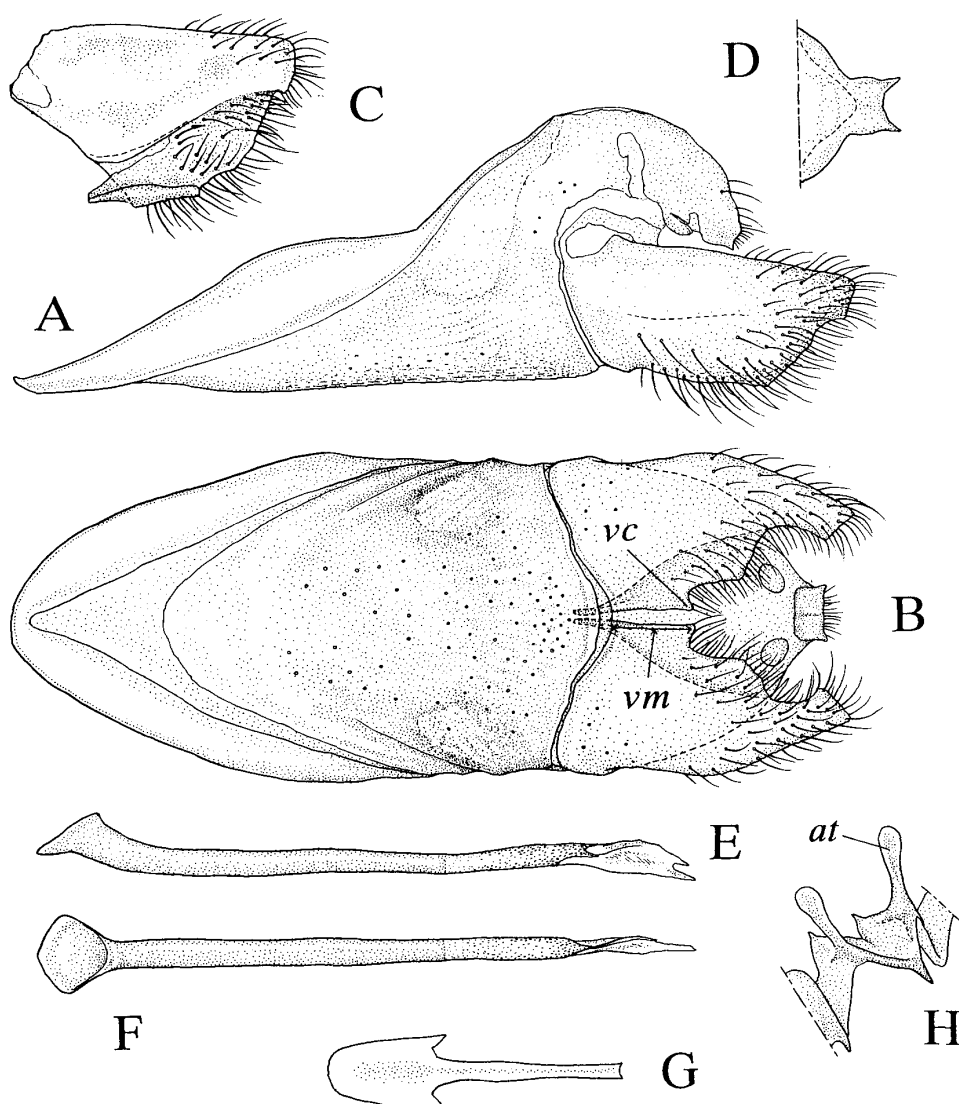


Fig. 9. Male genitalia of *A. reaumurella* (Linnaeus, 1758). A. Whole genitalia except aedeagus in lateral view. B. *Ditto*, ventral view. C. Right valva in internal view. D. Dorsum in dorsal view. E. Aedeagus in lateral view. F. *Ditto*, dorsal view. G. Juxta in ventral view. H. Transtilla in dorsolateral (slightly caudal) view. at: anterior process of transtilla, vc: ventro-posterior corner of valva, vm: basal part of ventral margin of valva.

Specimens examined. [Hokkaido] 1 ♀, Pyoutan, Nakasatsunai, 12. vi. 1993, K. Maeda; [Honshu] 1 ♀, Murakage, Anan, Shimoina, Nagano Pref., 30. iv. 1989, M. Ihara; 1 ♀, Kinno, Iida, Nagano Pref., M. Ihara; 1 ♂, Hikagedaira (1,340 m), Gifu, 2-4. vi. 1979, T. Saito; 1 ♀, Ashu, Kyoto Pref., 9. v. 1968, T. Yasuda; 1 ♂, Hanase, [Kyoto Pref.], 15. v. 1952, A. Mutuura; Nose, Settu [N. Osaka], 3. v. 1953, T. Yasuda; 1 ♂, same locality and date, S. Fujimoto; 1 ♀, Mt Mikusayama, Osaka Pref., 3. v. 1992, T. Ueda; 1 ♂, Hirakata, Osaka Pref., 26. iv. 1993, T. Hirowatari; 2 ♂, Izumi-Katsuragi, Osaka Pref., 10. v. 1992, T. Hirowatari; 1 ♀, same locality, 16. v. 1993, T. Ueda; 2 ♂, Mt Obakodake, Nara Pref., 17. v. 1992, T. Hirowatari; 1 ♂, same locality and date, T. Ueda; [Kyushu] 1 ♂, Izumimura, Kumamoto Pref., 14. v. 1980 [L.T.], N. Koda.

Distribution. Japan (Hokkaido, Honshu, Shikoku, Kyushu), Europe to East Asia.

Remarks. Moriuti (1982) suggested that the Japanese representative of *A. reaumurella* might be a different subspecies, because the shape of the 'tegumen' is slightly different. As he pointed out the processes of the uncus sensu Nielsen (1985) are rather shorter than those of European ones, and furthermore, the male eyes are somewhat smaller. This may suggest that the Japanese representatives are possibly a distinct species. However, on the other hand, Kozlov & Robinson (1996) indicated geographical variation of the eye size in *Nemophora decisella* (Walker). I defer the taxonomic change here until sufficient materials of this group from Europe to East Asia are investigated.

***Adela luteocilis* sp. nov.** (Figs 3, 6A-B, 7A, 10, 13B)

Male. Forewing 9.0 mm in holotype; 9.14 ± 0.36 mm (mean \pm SD, $n=14$). Head with raised black hairs, sparsely set with yellow; face smooth and bronzy, black hairs laterally, upper part (between antennae) black hairs mixed with yellow. Eyes small, horizontal eye diameter (hd)/minimum distance between eyes (md): 0.86 in holotype, 0.86 ± 0.03 (mean \pm SD, $n=14$). Labial palpus long, just beyond vertex, densely covered with raised brown hairs. Antenna long, antennal length (al)/forewing length (fl): 3.5 in holotype, 3.33 ± 0.14 (mean \pm SD, $n=14$); basal 1/5 dark bronzy, distal 4/5 silvery white. Legs bronzy with golden or purple luster; hind tibia bronzy with short hairs ventrally and with long curled hairs dorsally; hind tarsus bronzy, with apical silvery white rings. Forewing with R_3 and R_4 stalked; basal half golden bronzy, purple luster along costa; a transverse white fascia relatively broad, margined with brownish scales of metallic purple luster; apical 1/3 dark brown with purple luster, radiately scattered with golden yellowish scales. Hindwing dark brown with a yellowish patch at discal cell end to costa; cilia ochreous to dark brown at termen, pale yellow at dorsum.

Female. Forewing 8.29 ± 0.24 mm (mean \pm SD, $n=10$). Head with raised yellow hairs, sparsely mixed with black; face smooth and golden, lateral and upper parts (between antennae) with yellow hairs. Eyes small, horizontal eye diameter (hd)/minimum distance between eyes (md): 0.56 ± 0.04 (mean \pm SD, $n=10$). Antenna short, antennal length (al)/forewing length (fl): 1.39 ± 0.09 (mean \pm SD, $n=10$); basal 1/3 covered with rough, but somewhat smooth black scales. Hindwing as in male, but basal half somewhat paler.

Male genitalia. Uncus short; posterior margin weakly produced posteriorly at lateral corners. Valva basal half subquadrate, distal half dilated posteriorly in lateral view; inner wall with a triangular apical hook; basal part of ventral margin long, about 1/3 of valva; ventro-posterior corner obtusely angled. Anterior process of transtilla thorn-like. Aedeagus long and slender; anterior portion of subzonal sheath somewhat curved dorsally. Juxta arrow-shaped; head large ellipsoidal with prominent barbs.

Female genitalia. Apophyses posteriores and anteriores subequal in length. Vestibulum relatively large, vestibular lamella nearly V-shaped in ventral view, separated at middle.

Holotype ♂, Mt Obakodake, Nara Pref., Honshu, 17. v. 1992, T. Hirowatari, in OPU. Paratypes. [Honshu] 2 ♂, same label as holotype; 2 ♂ 3 ♀, 21. v. 1992; 12 ♂ 7 ♀, 26. v. 1993; 2 ♂, 27. v. 1995, same locality and collector; 7 ♂ 1 ♀, same locality, 26. v. 1993, T. Ueda; 1 ♂, same locality and collector (UT); 1 ♂, same locality, 27. v. 1995, Y. Nakatani; 3 ♂, Mt Gomadansan, Wakayama Pref., 20. v. 1990, T. Hirowatari; 1 ♂, Odaigahara, Nara, 7. vi. 1970, S. Moriuti.

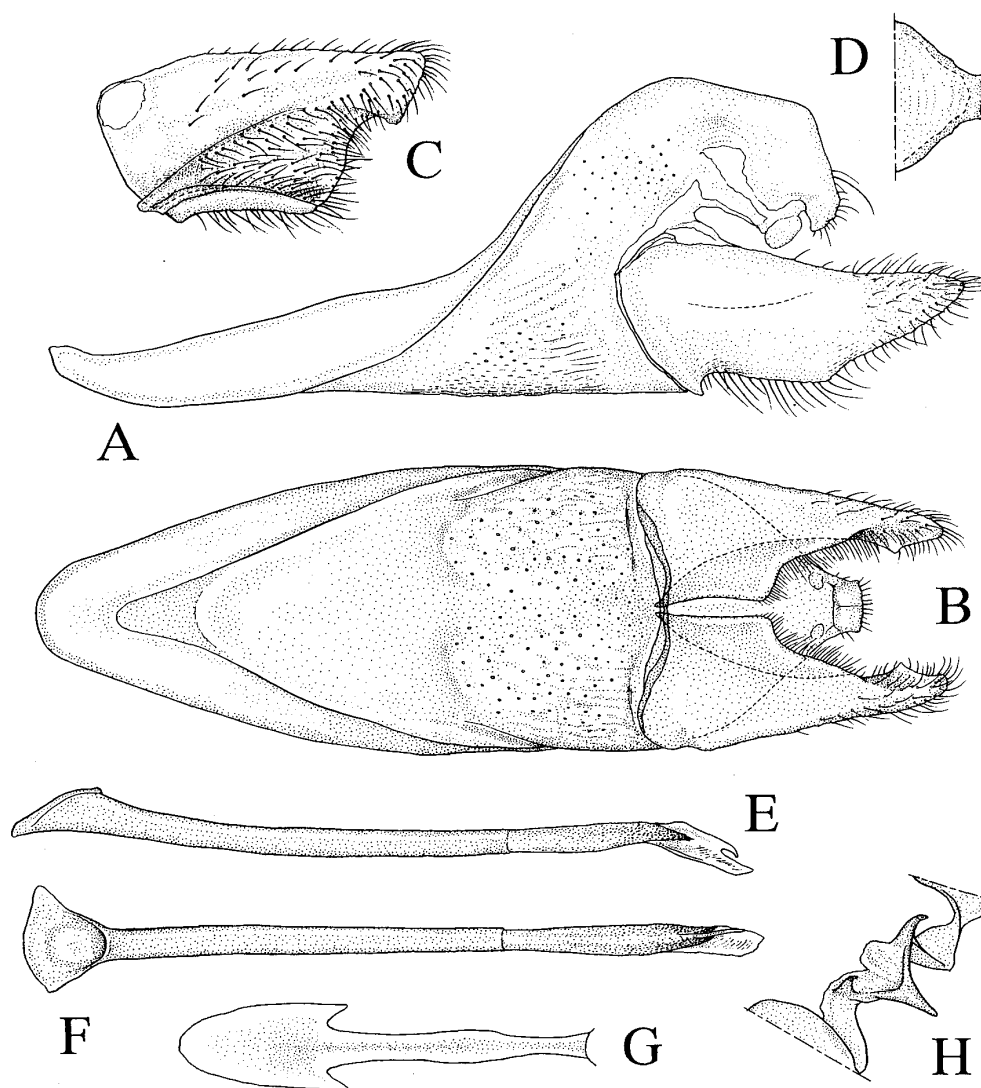


Fig. 10. Male genitalia of *A. luteocilis* sp. no., paratype. A. Whole genitalia except aedeagus in lateral view. B. *Ditto*, ventral view. C. Right valva in internal view. D. Dorsum in dorsal view. E. Aedeagus in lateral view. F. *Ditto*, dorsal view. G. Juxta in ventral view. H. Transtilla in dorsolateral (slightly caudal) view.

Other materials. [Honshu] 1 ♂, Aotayama, Oshika V., Nagano Pref., 22. v. 1990, M. Ihara ; 1 ♂, Tonjiro, Yasuoka, Shimoina, Nagano Pref., 29. iv. 1985, M. Ihara ; 1 ♂, Koukura-toge, Fujihashi V., Gifu Pref., 9–10. v. 1997, Y. Nakatani ; 2 ♀, Mt Hasshoudake, Kinomoto-cho, Shiga Pref., 18–21. v. 1993, Y.S. Bae ; 1 ♂, Mt Outousan, Wakayama Pref., 6. v. 1995, T. Hirowatari.

Distribution. Japan (Honshu [Nagano, Gifu, Shiga, Nara and Wakayama Prefectures]).

Remarks. This species resembles *A. praepilosa* sp. nov. externally, but is distinguished from the latter by the yellowish cilia of the hindwing, and in the male, by the longer antenna and the smaller eyes.

Most of the type materials were collected at a western ridge of Mt Obakodade, Nosegawa Village, Nara Prefecture, *ca* 1,000 m above sea level. I observed many individuals of this

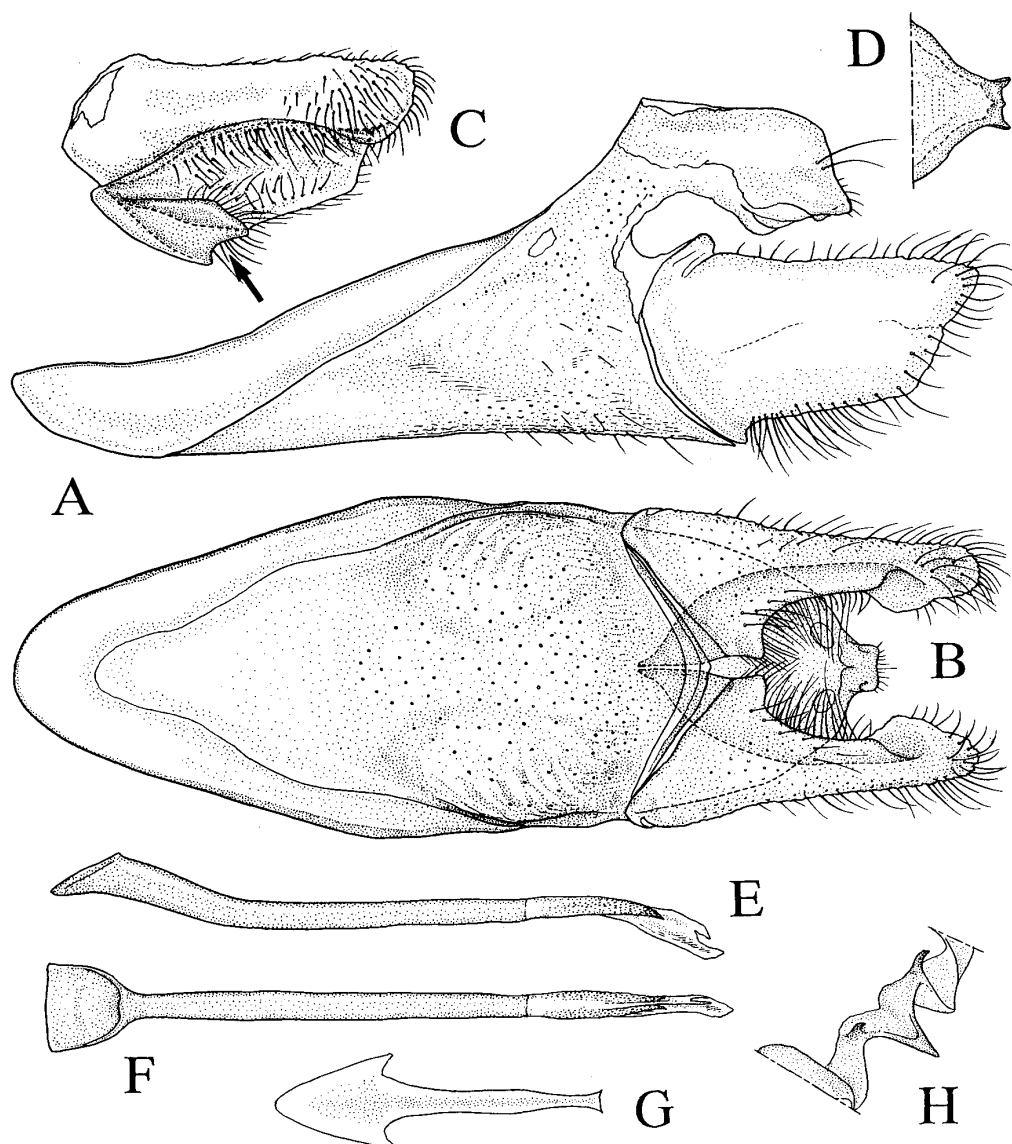


Fig. 11. Male genitalia of *A. luminaris* sp. nov., holotype. A. Whole genitalia except aedeagus in lateral view. B. *Ditto*, ventral view. C. Right valva in internal view. D. Dorsum in dorsal view. E. Aedeagus in lateral view. F. *Ditto*, dorsal view. G. Juxta in ventral view. H. Transtilla in dorsolateral (slightly caudal) view. Arrow indicates difference to *A. praepilosa*.

species visiting the flowers of *Acer* sp. (Aceraceae) at about 3 m with *A. praepilosa* sp. nov., but it was not clear whether the males of this species swarm or not.

***Adela luminaris* sp. nov.** (Figs 4, 7B, 11, 13D)

Adela nobilis Christoph : Kuroko, 1966, 152, pl. 64, fig. 18 (misidentification) [examined].

Male. Forewing 8.5 mm in holotype; 8.50 ± 0.53 mm (mean \pm SD, $n=10$). Head with raised pale yellow hairs, mixed with black; face smooth and bronzy, black hairs laterally, upper part (between antennae) with yellow hairs. Eyes small, horizontal eye diameter (hd)/minimum distance between eyes (md): 0.88 in holotype, 0.83 ± 0.05 (mean \pm SD, $n=10$). Labial palpus long, just beyond vertex, densely covered with raised brown hairs. Antenna

long, antennal length (al)/forewing length (fl): 3.5 in holotype, 3.63 ± 0.21 (mean \pm SD, $n=10$); basal 1/6 dark bronzy, distal 5/6 silvery white. Legs bronzy with golden or purplish luster; hind tibia bronzy with short hairs ventrally and long curled hairs dorsally; hind tarsus bronzy, with apical silvery white rings. Forewing with R_3 and R_4 free; basal half golden bronzy, purple luster along costa; transverse white fascia narrow, narrowest at costa, broadly margined with metallic purple to blue luster; apical 1/3 dark brown with purple luster, radiately scattered with golden yellowish scales. Hindwing uniformly fuscous to dark brown; cilia ochreous to dark brown.

Female. Forewing 7.78 ± 0.53 mm (mean \pm SD, $n=5$). Head with raised yellow hairs, sparsely mixed with black; face pale yellow to golden, black and yellow hairs laterally, upper part (between antennae) with yellow hairs. Eyes small, horizontal eye diameter (hd)/minimum distance between eyes (md): 0.54 ± 0.01 (mean \pm SD, $n=5$). Antenna short, antennal length (al)/forewing length (fl): 1.54 ± 0.09 (mean \pm SD, $n=5$); basal half covered with rough black scales. Hindwing as in male.

Male genitalia. Uncus short; posterior margin weakly produced posteriorly at lateral corners. Valva subquadrate in lateral view; distal half rounded blade-like; basal part of ventral margin short, about 1/10 of valva; ventro-posterior corner nearly right-angled. Anterior process of transtilla thorn-like. Aedeagus long and slender; subzonal sheath weakly curved dorsally at anterior 2/5. Juxta arrow-shaped; head triangular with prominent barbs.

Female genitalia. Apophyses posteriores and anteriores subequal in length. Vestibulum relatively large; vestibular lamella well-developed, subquadrate in ventral view, with median keel.

Holotype ♂, Mt Hikosan, Fukuoka Pref., Kyushu, 4. v. 1993, T. Hirowatari, in OPU. Paratypes. [Kyushu] 4 ♂, same label as holotype; 1 ♂, same locality, 28. iv. 1954, H. Kuroko; 1 ♂, 28. iv. 1958, same locality, H. Kuroko; 3 ♂, Mt Inunaki, Fukuoka Pref., 11. iv. 1979, I. Kanazawa (OMNH); 3 ♂, same locality and date, T. Goto; 12 ♂ 8 ♀, same locality, 22. iv. 1986, N. Koda; 1 ♂, same label (UT); 5 ♂ 1 ♀, same locality, 2. v. 1963, T.S. (SEHU).

Other materials. [Honshu] 1 ♂, Mt Daisen, Tottori Pref., 20. v. 1981, S. Hashimoto.

Distribution. Japan (Honshu [Tottori Pref.] and Kyushu [Fukuoka Pref.]).

Remarks. This species is distinguished from *A. luteocilis* sp. nov. and *A. praepilosa* sp. nov. by the uniformly dark brown hindwing, while in the latter, a pale yellowish patch is present at cell end to costa. At localities of Mt Hikosan and Mt Inunakisan, Fukuoka Prefecture, this species was collected with *A. praepilosa* sp. nov. at the same site on the flowers of *Acer* sp. (Aceraceae). Judging from the shape of male valva, this species is considered to be most closely related to *A. praepilosa* sp. nov. in spite of the differences of antennal length and eye size in the male.

Adela praepilosa sp. nov. (Figs 5, 6C, 7C, 12, 14)

Adela nobilis Christoph: Matsumura, 1931: 1110; Matsumura, 1932: 127, pl. 4, fig. 24; Issiki, 1957: 12, pl. 1, fig. 23; Okano, 1959: 277, pl. 183, fig. 6; Moriuti, 1982: 1: 53, 2: pl. 1, figs 24, 25 (misidentification) [examined].

Male. Forewing 9.0 mm in holotype, 9.50 ± 0.52 mm (mean \pm SD, $n=33$). Head with

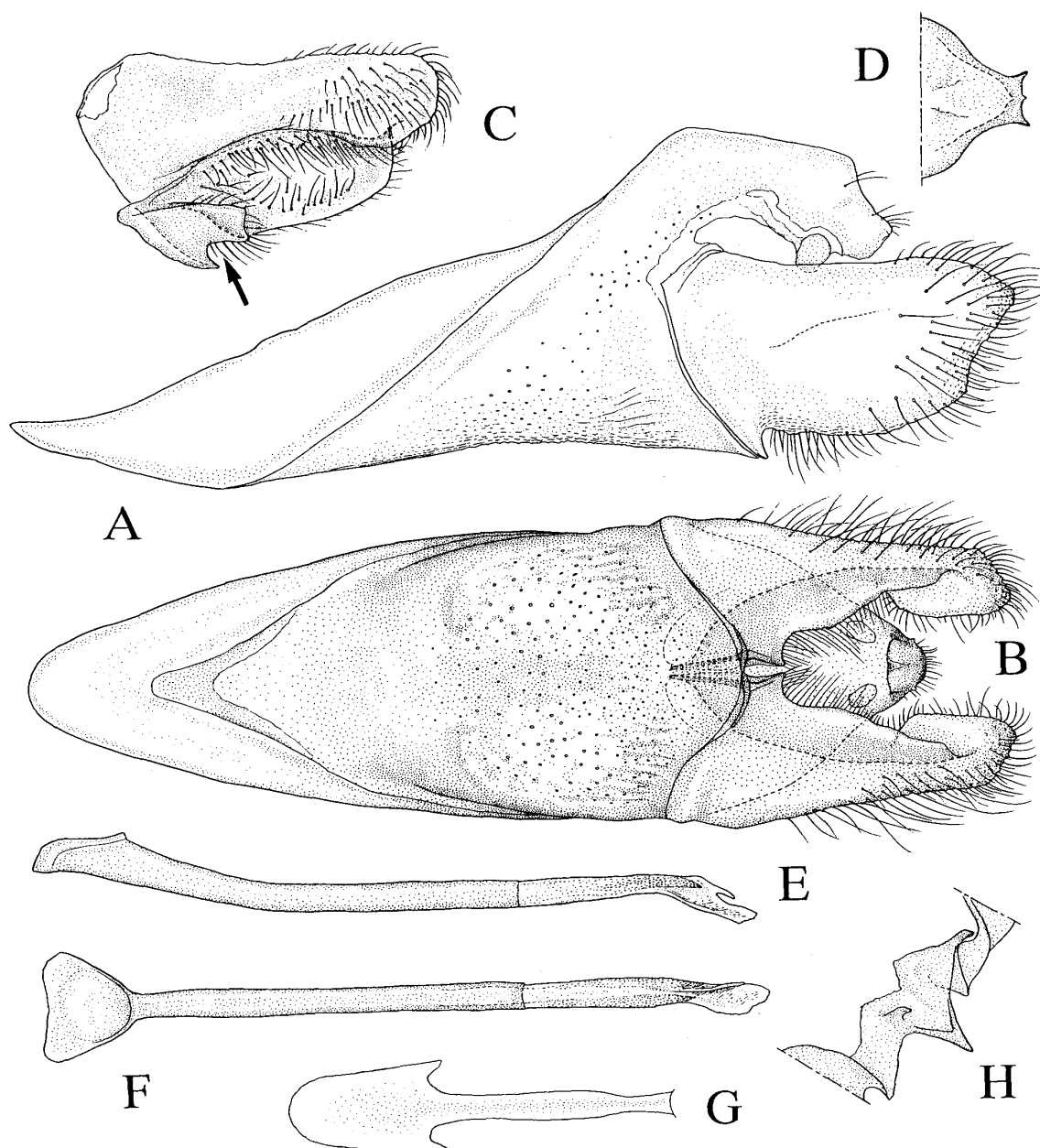


Fig. 12. Male genitalia of *A. praepilosa* sp. nov., paratype. A. Whole genitalia except aedeagus in lateral view. B. *Ditto*, ventral view. C. Right valva in internal view. D. Dorsum in dorsal view. E. Aedeagus in lateral view. F. *Ditto*, dorsal view. G. Juxta in ventral view. H. Transtilla in dorsolateral (slightly caudal) view. Arrow indicates difference to *A. luminaris*.

raised black hairs; face smooth and bronzy but almost hidden by dense hairs of labial palpus; dark brown hairs laterally, upper part (between antennae) with dark brown hairs. Eyes large, horizontal eye diameter (hd)/minimum distance between eyes (md): 1.7 in holotype, 1.87 ± 0.17 (mean \pm SD, $n=33$). Labial palpus very long, apparently beyond vertex, extremely densely covered with raised brown hairs. Antenna relatively short, antennal length (al)/forewing length (fl): 2.4 in holotype, 2.27 ± 0.16 (mean \pm SD, $n=33$); basal 2/5 dark bronzy, covered basally with raised pale yellow hairs and laterally with brown

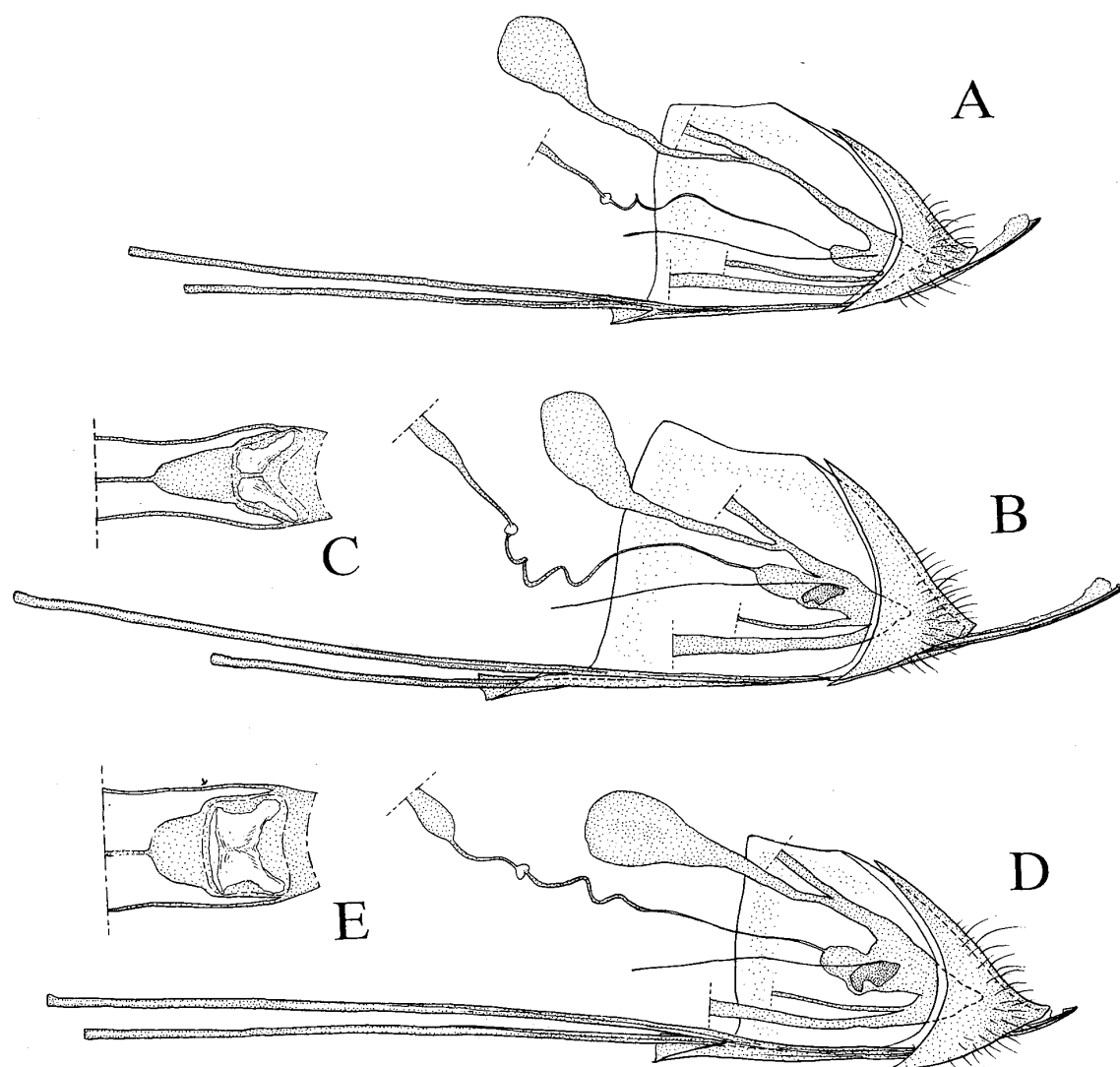


Fig. 13. Female genitalia of *Adela* spp. A. *A. reaumurella* (Linnaeus, 1758). B, C. *A. luteocilis* sp. nov. D, E. *A. luminaris* sp. nov. A, B, D. Terminalia in lateral view. C, E. Vestibulum in ventral view.

hairs; distal 3/5 silvery white. Legs bronzy with golden or purplish luster; hind tibia bronzy with short hairs ventrally and densely with long pale brown raised-hairs dorsally; hind tarsus with apical silvery white rings. Forewing with R_3 and R_4 stalked; basal half golden bronzy, purple luster along costa; a transverse white fascia relatively broad, margined with brownish scales of metallic purple luster; apical 1/3 dark brown with purplish luster, radiately scattered with golden yellowish scales. Hindwing dark brown with yellowish patch as in *luteocilis*; cilia ochreous to dark brown.

Female. Forewing 8.51 ± 0.56 mm (mean \pm SD, $n=13$). Head with raised yellow hairs, sparsely mixed with black; face smooth and silvery, upper part (between antennae) with yellow hairs. Eyes small, horizontal eye diameter (hd)/minimum distance between eyes (md): 0.57 ± 0.03 (mean \pm SD, $n=13$). Antenna short, antennal length (al)/forewing length (fl): 1.38 ± 0.05 (mean \pm SD, $n=13$); basal half covered with black scales. Hindwing as in male.

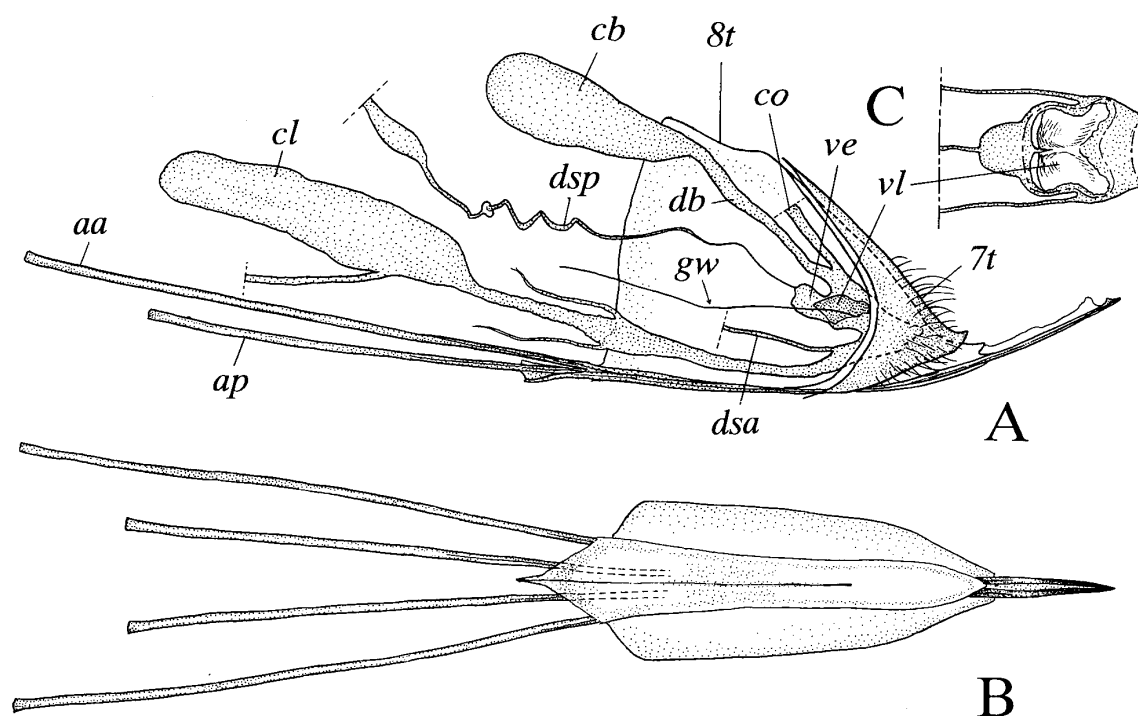


Fig. 14. Female genitalia of *Adela praepilosa* sp. nov. A. Terminalia in lateral view. B. *Ditto* in ventral view. C. Vestibulum in ventral view. aa: apophysis anterioris, ap: apophysis posterioris, cb: corpus bursae, cl: cloaca, co: common oviduct; db: ductus bursae, dsa: ductus sabaceus; dsp: ductus spermatheca, gw: guy wire, ve: vestibulum, vl: vestibular lamella, 7t: 7th tergite, 8t: 8th tergite.

Male genitalia. Similar to those of *A. luminaris* sp. nov., but ventro-posterior corner of valva rather acute and valva ventrally emarginate along anterior margin (Figs 11A, C). Anterior process of transtilla thorn-like. Aedeagus long and slender; subzonal sheath weakly curved dorsally at anterior 3/7. Juxta arrow-shaped; head large with prominent barbs.

Female genitalia. Apophyses posteriores and anteriores subequal in length. Vestibulum relatively large; vestibular lamella well-developed, similar to that of *A. luminaris* sp. nov., but rather longer and posterior margin more emarginate at middle.

Holotype ♂, Mt Obakodake, Nara Pref., Honshu, 26. v. 1993, T. Hirowatari, in OPU. **Paratypes.** [Honshu] 4 ♂ 1 ♀, same label as holotype; 2 ♂, 17. v. 1992, 1 ♀, 21. v. 1992, 5 ♂ 3 ♀, 27. v. 1995, same locality, T. Hirowatari; 1 ♂ 1 ♀, 17. v. 1992, 2 ♂, 26. v. 1993, 2 ♂, 27. v. 1995, same locality, T. Ueda.

Other materials. [Honshu] 1 ♂, Mt Iwate-san, [Iwate Pref.], 16. v. 1967, T. Oku; 2 ♂, Otori-damu, Tadami-cho, Fukushima Pref., 8–9. v. 1994, K. Ikeuchi; 1 ♂, Shigakogen, [Nagano Pref.], 10. v. 1957, T. Yasuda; 1 ♂, same locality, 16. v. 1957, T. Yasuda; Shimajima-dani, Azumi V., 22. v. 1976, N. Hirano; 3 ♀, Ueno, 820 m, Azusagawa V., Nagano Pref., 28. v. 1978, N. Hirano; 1 ♂, Gifu, 10. iv. 1920, Takeuchi; 2 ♂, same locality, 15. iv. 1920, Takeuchi; Hikagedaira (1,340 m), Gifu Pref., 2–4. vi. 1979, T. Saito; 1 ♂ 1 ♀, Mt Rokusho-san, Toyota, Aichi Pref., 9. v. 1976, Y. Arita; 2 ♂, Koukura-toge, Fujihashi V., Gifu Pref., 9–10. v. 1997, Y. Nakatani (OPU); 2 ♂, Mt Hiei, Kyoto, Takeuchi; 2 ♂ 1 ♀, Mioken [Myoken, Osaka], 18. iv. 1951, A. Mutuura; 4 ♂, same locality, A. Mutuura; 4

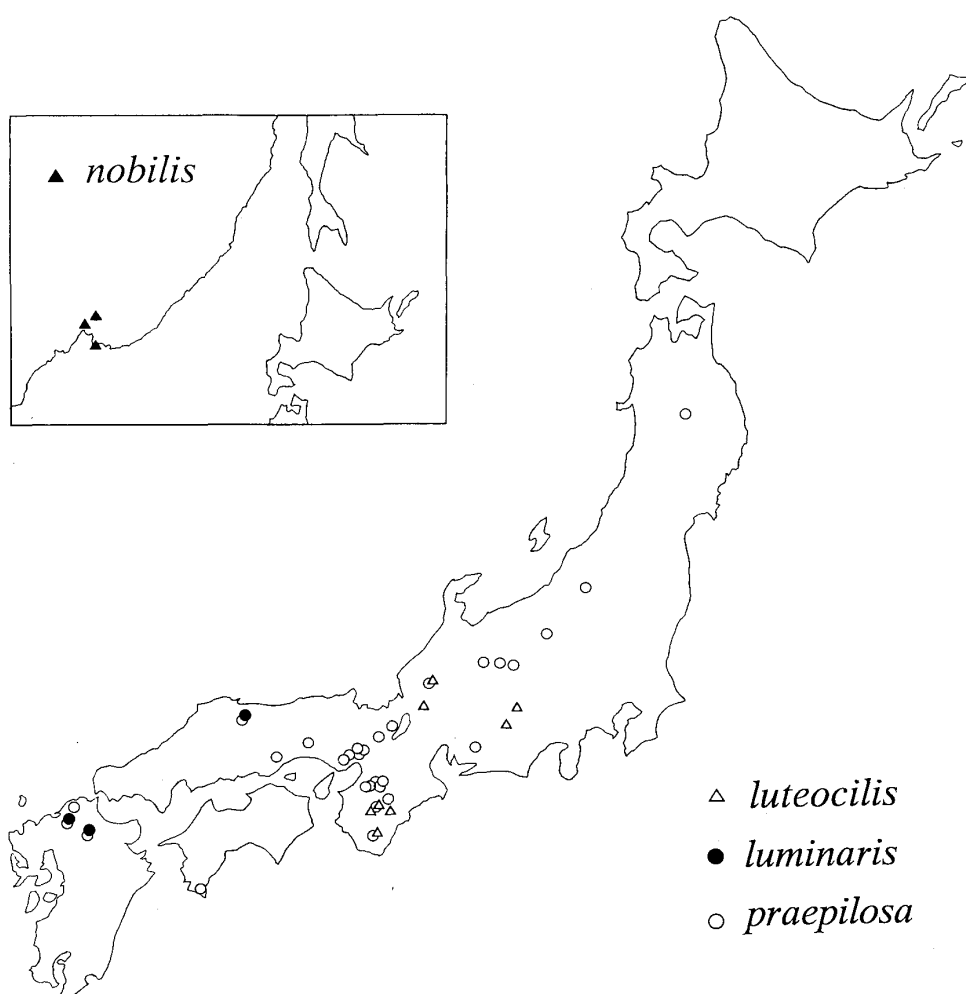


Fig. 15. Collecting localities of examined specimens of *Adela* spp.

♂ 1 ♀, Nose, Settsu [N. Osaka], 3. v. 1953, S. Fujimoto ; 4 ♂, same locality and date, T. Yasuda ; 1 ♀, Mt Mikusayama, Osaka Pref., 3. v. 1992, T. Hirowatari ; 1 ♀, same locality, 12. v. 1993, T. Hirowatari ; 1 ♂, Minoo, Osaka Pref. 23. iv. 1981, K. Yasuda ; Mt Kongosan, Osaka Pref., 29. iv. 1966, Y. Arita ; 3 ♂, 11. v. 1996, same locality, K. Nigoro & T. Hirowatari ; 1 ♂, Iwawaki, Osaka, 17. iv. 1952, 1 ♂, 29. iv. 1953, T. Kodama ; 3 ♂, same locality, 27. iv. 1952, T. Kodama ; 1 ♂, 5. v. 1954, 1 ♀, 1. v. 1961, same locality, T. Yasuda ; 2 ♂, same locality, 1. v. 1961, T. Saito ; 1 ♂, Makinoosan, 23. iv. 1960, T. Saito ; 1 ♂, same locality, 16. iv. 1964, M. Takahama ; 1 ♂, Izumi-Katsuragi, Osaka Pref., 5. v. 1992, T. Hirowatari ; 1 ♀, same locality, 16. v. 1993, T. Ueda ; 1 ♀, same locality, 10. v. 1994, T. Hirowatari ; 2 ♀, same locality, 7. v. 1994, H. Yamamoto ; 4 ♂, same locality, 9. v. 1995, H. Miyake ; 1 ♀, Mt Wasamata, Nara Pref., 16. vi. 1993, T. Hirowatari ; 2 ♂, same locality, 27. v. 1993, N. Hirai ; 2 ♂ 1 ♀, same locality, 1. vi. 1996, K. Nigoro & T. Hirowatari ; 1 ♂, Kimitoge, Wakayama Pref., 1. v. 1994, T. Hirowatari ; 10 ♂, Mt Otousan, Wakayama Pref., 6. v. 1995, T. Hirowatari ; 2 ♂, Shirakawa, Kobe Kita-ku, 18. iv. 1991, T. Yasuda & Y.S. Bae ; 1 ♂, [Dojo, Hyogo Pref.], 20. iv. 1969 ; 2 ♂ 1 ♀, Yamazaki-cho, Hyogo Pref., 28. iv. 1991, S. Hashimoto ; 1 ♀, Daisen, [Tottori Pref.], 7. vi. 1933, K. Takeuchi ; 1 ♂, same locality, 20. v. 1981, S. Hashimoto ; 17 ♂ 4 ♀, Awai, Okayama City, Okayama Pref., 26–27. iv. 1995, T. Ueda ; 1 ♂, same label (UT), [Shikoku] 2 ♂,

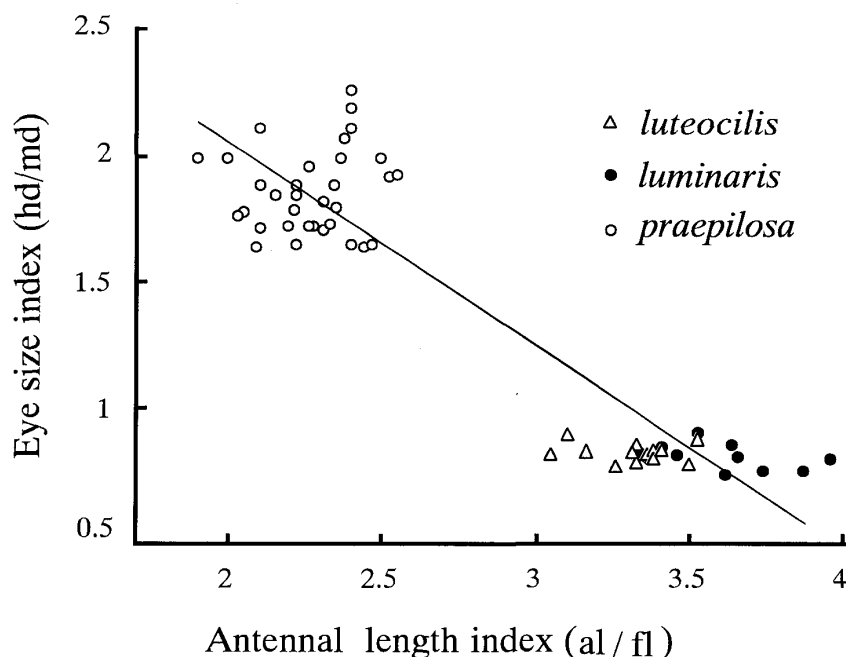


Fig. 16. Eye size index of *A. luteocilis*, *A. luminaris* and *A. praepilosa* in relation to the antennal length index ($y = -0.78x + 3.6$, $R^2 = 0.85$).

Imanoyama, 12.v. 1951, A. Mutuura; [Kyushu] 1 ♀, Mt Jouyama, Fukuoka Pref., 4. v. 1991, T. Hirowatari; 5 ♂ 1 ♀, Mt Inunaki, Fukuoka Pref., 22 iv. 1986, N. Koda; 1 ♀, Mt Hikosan, (Buzen) [Fukuoka Pref.], 28. iv. 1958, H. Kuroko; 1 ♀, same locality, 8. v. 1954, H. Kuroko; 4 ♂, same locality, 4. v. 1993, T. Hirowatari.

Distribution. Japan (Honshu, Shikoku, Kyushu).

Remarks. This species has long been confused with *A. nobilis* Christoph, 1882 which is probably confined to the Russian Far East and its adjacent areas. This species is distinguishable from all other Japanese species by the densely-haired labial palpus and the shorter antenna in the male. The adults fly in late spring, being observed to visit the flowers of *Rhododendron reticulatum* (Ericaceae) (T. Ueda & Y. Nakatani *pers. comm.*) and *Acer* sp. (Aceraceae).

By courtesy of Mr Fukuo Ito, I observed the swarming of this species at Ouda-cho, Nara Prefecture on 29 April 1997 in fine weather around noon. The males of this species swarmed just above the flowers of *Spiraea thunbergii* (Rosaceae) at about 1.5 m in the sunlight, performing a zigzagging swarm of about 20 cm in amplitude.

Discussion

Nielsen (1980) noted that many species of *Nemophora* and *Adela* with large eyes are known to swarm. This is applicable to *A. praepilosa* sp. nov. which bears large eyes with short antennae and performs vertical zigzagging swarming. On the other hand, precopulatory behavior of *A. luminaris* sp. nov. and *A. luteocilis* sp. nov. which bear small eyes with long antennae, is unknown. The small eyes do not necessarily mean that they do not swarm because the male eyes of *A. luminaris* sp. nov. and *A. luteocilis* sp. nov. are more or less larger than those of females in each species. In their study on sexual dimorphism in relation to

swarming in leptocerid caddisflies, Gullefors & Petersson (1993) indicated that the vertical zigzagging species have larger eyes in the male. It may possibly be predicted that the precopulatory flight behavior of *A. luminaris* sp. nov. and *A. luteocilis* sp. nov. is different from that of *A. praepilosa* sp. nov.

Kozlov (1987) divided the adelid moths into 2 groups, non-swarming and swarming species. According to Kozlov, the males of non-swarming species fly singly to search for females which spend most of their time resting on the grasses, while in swarming species, females enter the swarm to mate. In all the cases, the adelid moths have been considered to recognize other individuals by visual stimuli (Kozlov, 1987).

In Japanese adelids, to my knowledge, only *Nemophora albi antennella* Issiki is reported as a non-swarming species sensu Kozlov (Hirowatari and Yamanaka, 1996). In this species, sexual dimorphism is not recognized in eye size, i. e., the male eyes (hd/md : 0.44 ± 0.03 ; $n=10$) are small as in the females (hd/md : 0.42 ± 0.02 ; $n=8$). There seems a greater likelihood that this species searches for females partly or mainly by other than the visual sense (e. g., olfactory stimuli) with the long antennae (al/fl : 3.36 ± 0.17 ; $n=10$).

It is interesting to note that *A. praepilosa* sp. nov. is considered to be closely related to *A. luminaris* sp. nov. judging from the shape of valvae. It follows therefore that modification of eye size and antenna length have evolved independently even among closely related species. Furthermore, the eye size is negatively correlated with the antenna length in these species ($R^2=0.85$, Fig. 16). This may suggest that males search for other individuals by sight and (/or) by other sense such as olfactory stimuli complementarily, and modification of eye size and antennal length have evolved to enhance either of two senses in each species. Further investigations on precopulatory behavior and character evolution of adelid species are needed.

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摘 要

日本産 *Adela* 属 (鱗翅目, ヒゲナガガ科) の分類学的再検討 (広渡俊哉)

これまで, *Adela* 属の種として日本からミドリヒゲナガ *A. reaumurella* (Linnaeus) とケブカヒゲナガの2種のみが知られていた。今回, 日本産 *Adela* 属の分類学的再検討を行った結果, *A. nobilis* Christoph とされていたケブカヒゲナガは, 独立種であることが明らかになり, *A. praepilosa* sp. nov. とし記載した。さらに, 2新種 *A. luteocilis* sp. nov. (アトキケブカヒゲナガ: 新称), *A. luminaris* sp. nov. (ムモンケブカヒゲナガ: 新称) を見だし, 計4種が日本に分布することがわかった。なお, *A. nobilis* Christoph, 1882 は, 基産地であるウラジオストク周辺のロシア沿海州などに分布し, おそらく日本には分布しない。

Adela 属は, ♂ の触角第8-9鞭節に特異な突起 (hook-peg) を持つことによって特徴づけられる。日本産 *Adela* 属は, ミドリヒゲナガとそれ以外の3種にグルーピングできる。ミドリヒゲナガでは, transtilla 側背面の突起がヘラ状で, ケブカヒゲナガを含む他の3種では, 刺状。また, ケブカヒゲナガを含む3種では雌交尾器の vestibulum に顕著な板状の骨片 (vestibular lamella) が存在するが, ミドリヒゲナガではこれを欠く。日本産の種はいずれも平地では4月下旬-5月上旬, 山地などでは5月-6月に見られる。成虫はカエデ類の花などに集まる。

Adela 属では, ♀ に比べて♂ の触角が長く複眼が大きいという性差が見られる。今回扱った種では, ♂ の複眼の大きさや触角の長さに種間差が認められた。複眼の大きさ, 触角の長さは, それぞれ hd/md (複眼の水平直径/複眼間の最短距離), al/fl (触角長/前翅長) で表した。

Nielsen (1980) は, *Adela* 属と *Nemophora* 属の種で, ♂ の複眼が大きいものはスウォーム (群飛) するものが多いとしている。実際, ケブカヒゲナガ *A. praepilosa* sp. nov. の♂ の複眼は大きく, スウォームすることが知られている。一方, アトキケブカヒゲナガ *A. luteocilis* sp. nov. とムモンケブカヒゲナガ *A. luminaris* sp. nov. では, ♂ の複眼は小さく, 触角が長い, これらの種がスウォームするかどうかは観察されていない。日本産の *Adela* 属と *Nemophora* 属でスウォームしないとされているのは, 現在のところクロハネシロヒゲナガ *Nemophora albiantennella* Issiki 1種のみである (Hirowatari & Yamanaka, 1996)。クロハネシロヒゲナガでは♂ の触角が長く (al/fl: 3.36 ± 0.02), 複眼の大きさに性差は認められない (hd/md: ♂ 0.44 ± 0.03 , ♀ 0.42 ± 0.02)。ヒゲナガガ科では, 他個体

の認識はすべて視覚によってなされていると考えられている。しかし、複眼が小さく、スウォームしないクロハネシロヒゲナガの♂は、単独で飛翔して♀を探索するが、この時視覚以外の感覚（嗅覚など）を用いていることも充分考えられる。

今回、雄交尾器、特に valva 形態から、複眼が小さく触角の長いムモンケブカヒゲナガと、複眼が大きく触角の短いケブカヒゲナガがもっとも近縁であると推定された。従って、♂の複眼の大きさや触角の長さは、各種でおそらく配偶行動と密接に関係しながら独立に進化したと考えられる。さらに、これらの種では複眼が大きいと触角が短く、複眼が小さいと触角が長かった。ただし、ムモンケブカヒゲナガとアトキケブカヒゲナガでは、複眼が小さいといっても♀よりは相対的に大きく、視覚で他個体を認識している可能性が高いが、その際、長い触角で嗅覚等、視覚以外の感覚を相補的に用いているのかもしれない。ヒゲナガガ科の配偶行動とそれに関わる形態の進化については、さらに多くの種で詳しく調べる必要がある。

以下に日本産各種の形態的特徴と分布などを示す。

A. reaumurella (Linnaeus, 1758) ミドリヒゲナガ

分布：北海道，本州，九州；ヨーロッパ。

前後翅とも一様に暗緑色の金属光沢を有しており、日本では他種と混同されることはない。雄交尾器の tegumen 後端の形態がヨーロッパ産のものに比べて異なっており（森内，1982），♂の複眼の大きさもヨーロッパ産のものよりやや小さいと思われるが、複眼の大きさは地理的変異があるという報告例もあるので（Kozlov & Robinson, 1996），ここでは従来扱いのままで保留した。

A. luteocilis sp. nov. (新種) アトキケブカヒゲナガ (新称)

分布：本州（長野県，岐阜県，滋賀県，和歌山県，奈良県 [伯母子岳，大台ヶ原]）。

♂の複眼は小さく ($hd/md: 0.86 \pm 0.03$)，触角は長い ($al/fl: 3.33 \pm 0.14$)。♂の頭頂毛，触角間毛は黄色。♀の触角の基部約3分の1が黒色鱗で覆われる。雌雄とも後翅の中室端から前縁部にかけて淡色の斑紋がある。後翅の縁毛が黄色であることで、他種と区別できる。

A. luminaris sp. nov. (新種) ムモンケブカヒゲナガ (新称)

分布：本州（大山），九州（福岡県 [英彦山，犬鳴山]）。

♂の複眼は小さく ($hd/md: 0.83 \pm 0.05$)，触角は長い ($al/fl: 3.63 \pm 0.21$)。♂の頭頂毛，触角間毛は黄色。♀の触角の基半部が黒色鱗で覆われる。雌雄ともに、後翅の中室端から前縁部にかけて淡色のパッチがなく、一様に茶褐色-黒紫色であることで、他種と区別できる。

A. praepilosa sp. nov. (新種) ケブカヒゲナガ

分布：本州，四国，九州。

これまで、*A. nobilis* と混同されてきた。♂の下唇鬚は密に長毛で覆われる。♂の頭頂毛，触角間毛は黒色。♂の複眼は大きく ($hd/md: 1.87 \pm 0.17$)，触角は比較的短い ($al/fl: 2.27 \pm 0.16$)。♀の触角の基半部が黒色鱗で覆われる。雌雄とも後翅の中室端から前縁部にかけて淡色の斑紋がある。後翅の縁毛は茶褐色。雄交尾器、特に valva の形状から、ムモンケブカヒゲナガに近縁であると思われる。これまで混同されていた *A. nobilis* とは、valva の形状の違いで区別できる。♂成虫はカエデ，コバノミツバツツジ，ユキヤナギの花の上でスウォームする。

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